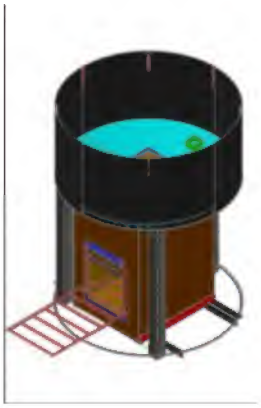
Institutional Rocket Stove (IRS) Assembly Guide

Designed by Peter Scott Oct 26 2010 2010
All dimensions are in mm unless otherwise noted

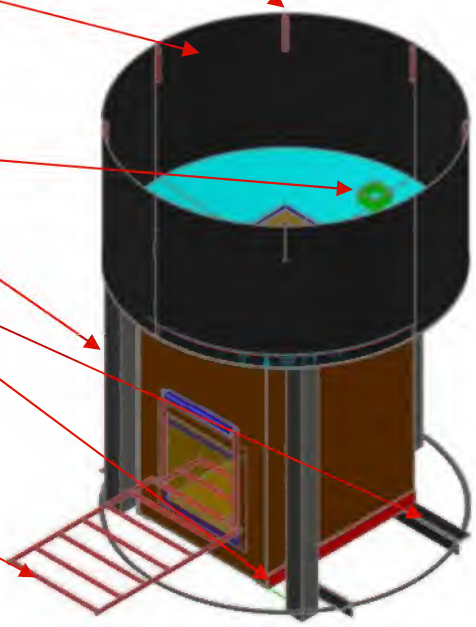


This guide should be used in conjunction with the accompanying **IRS excel guide**. All of the required dimensions will be produced automatically after inputting the following **5** dimensions in the **IRS Excel Guide**. The excel sheet can be printed and used as a cut list for the Assembly guide.

Outside circumference of pot (mm)	
Pot height (Pot Height) (mm)	
Pot height to the handles (Pot H to Handle) (mm)	
Thickness of combustion chamber liner (mm) see appendix A	
Thickness of combustion chamber insulation (mm) see Appendix A	

Materials needed for Stove Body Construction

- **Round Bar:** Use10 mm for Pot Stabilizer inside skirt
- **Sheet metal:** Use 2 mm thick sheet metal for stove skirt and body .
- **Legs and pot supports.** Use 40 mm wide by 1.5 – 3 mm thick square tube
- **Angle iron**: Use 30 by 30 by 3 mm thick
- **Round bar**: Use 12 mm for base
- **Round bar**: Use 10mm for wood support



1 MEASURING POT DIMENSIONS

Accurate measurement of the exterior dimensions of the cooking pot is critical. Use a soft/ flexible measuring tape when taking measurements. Take all measurements in millimeters. Three dimensions of the pot are needed: **the outside circumference of the pot measured at the widest point**, **the full height of the pot (H),** and **the height from the bottom of the pot to the bottom of the handles (h)**. **Input pot dimensions in the CIRS Excel guide.**

i. Pot circumference (C) _____ mm

ii. Full height of the Pot (H) _____ mm

iii. Height of pot to handle (h) _____ mm

1a Combustion Chamber Liner and Insulation Thickness

Choose a combustion chamber liner and insulation thickness that is appropriate for the materials that are available in your region. In Ethiopia we use a 30 mm thick ceramic liner surrounded by 50 mm of loose pumice Insulation. The goal is to develop a liner that can withstand thermal shock and abrasion as well being insulative. See Appendix A for more details

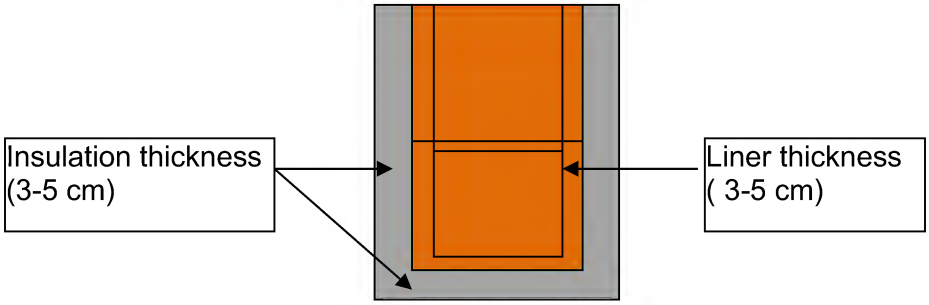
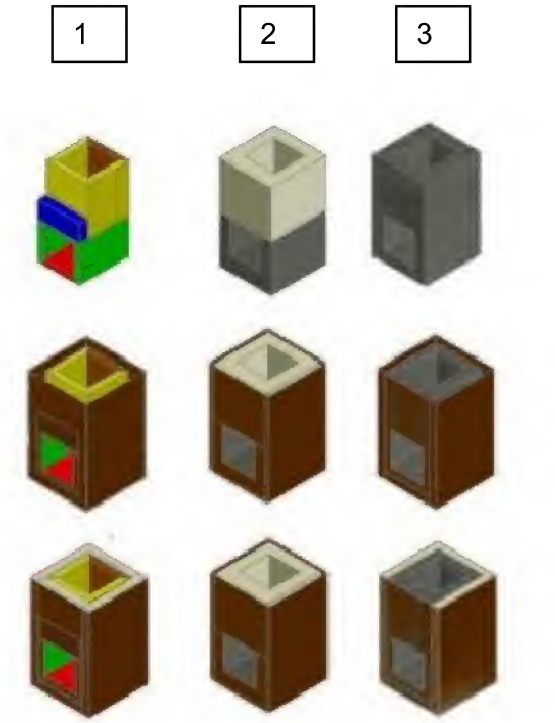


Figure 1.1 Front view of the clay liner and insulation material

In the **Assembly Guide** each required dimension is noted as F1, F2, F3, F4 etc. These correspond to the Formula 1,2,3,4 etc that are listed in the **CIRS excel guide**. Each component in the guide is color coded for easier reference to the formulas given in the excel guide. The formulas are calculated automatically after inputting the 5 dimensions noted above. If a computer is not available, the calculations can also be done by hand.

2 COMPONENTS OF CIRS

(COMBUSTION CHAMBER LINER)



3 OPTIONS ARE AVAILABLE FOR CONSTRUCTING THE COMBUSTION CHAMBER.

Option 1: high density (1.0 – 2.0 g/cc) abrasion resistant ceramic tiles surrounded by insulation

Option 2: feed chamber (gray brick, lower) is made from high density (1.0 – 2.0 g/cc) brick that can withstand thermal shock and is abrasion resistant. The area above the feed chamber (white brick, upper) is made with low-density (.8 – 1.0 g/cc) insulative ceramic.

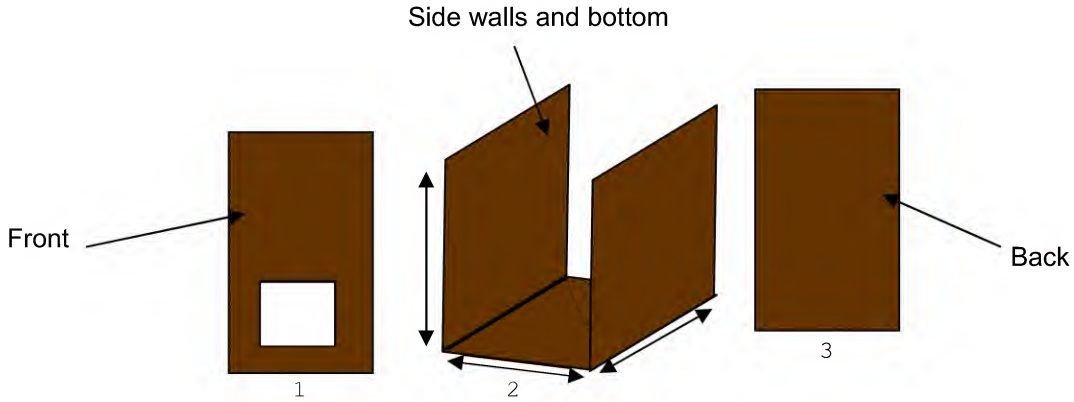
option 3 common brick surrounded by insulation .

This manual utilizes option 1.

3 PRODUCE THE SHEET METAL CLADDING FOR THE COMBUSTION CHAMBER

The metal box for the combustion chamber is prepared from three separate pieces of 1.5mm mild steel sheet. The two side walls and the bottom are made from a single section of sheet metal. Two separate pieces of sheet metal are used to make the front and back sections.

Figure 3.1 Pieces of sheet metal for combustion chamber cladding

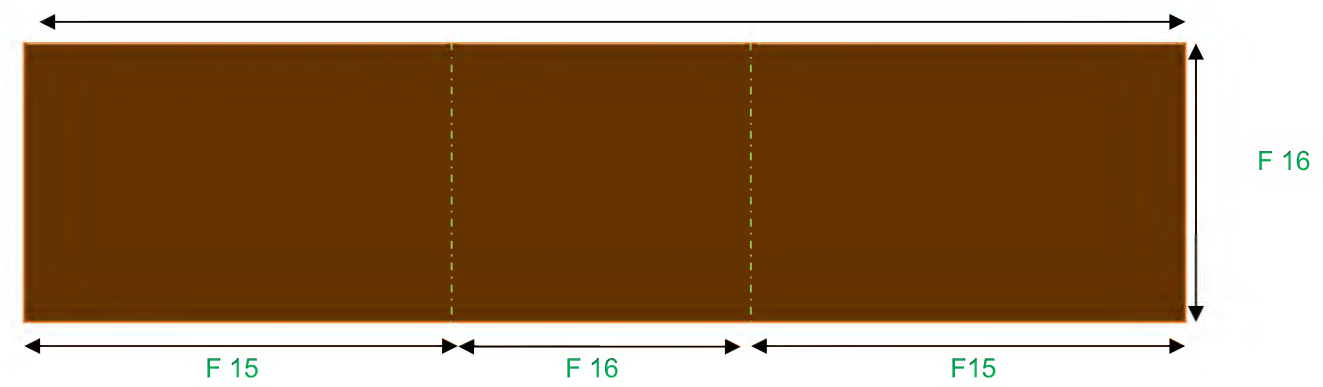


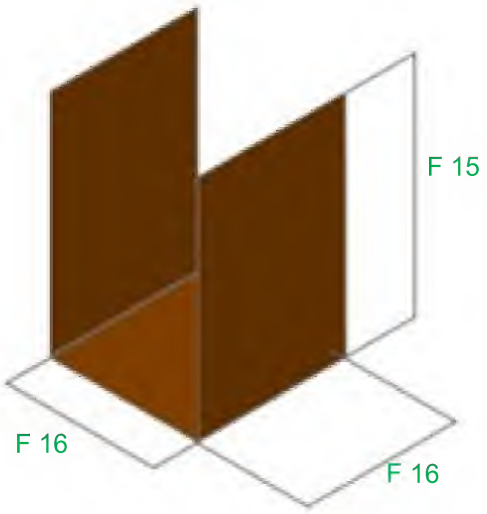
3a. Produce the bottom and two sides of the metal combustion chamber

The thickness of the clay liner and insulation (entered in the CIRS excel guide) will determine the size of the combustion chamber box dimensions.

Cut a piece of sheet metal with dimensions indicated by Formula **15 and 16** and fold it as shown in Figure 4.2 below to make the sides and the bottom of the combustion chamber.

Figure 3.2 Fold the sheet metal to make the sides and bottom of the combustion chamber





3b. Produce the face plate of the metal combustion chamber

To produce the front plate of the metal combustion chamber, cut a piece of 1.5 mm mild steel with dimensions as indicated by Formula **17 and 18**. .

The face plate and the back plate of the combustion chamber are equal except that the front plate has an opening for the fuel inlet equal to Formula **4.** The distance from the **bottom** of the face plate to the **bottom** of the fuel inlet is given by Formula **19.**

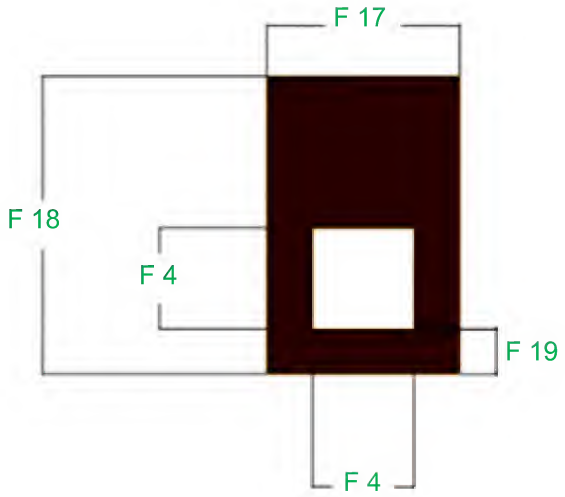


Figure 3.4: Dimension of the front plate of the combustion chamber

3c. Produce the back plate of the metal combustion chamber

To produce the back plate of the metal combustion chamber, cut a piece of 1.5 mm mild steel with dimensions as indicated by Formula **17 and 18**.

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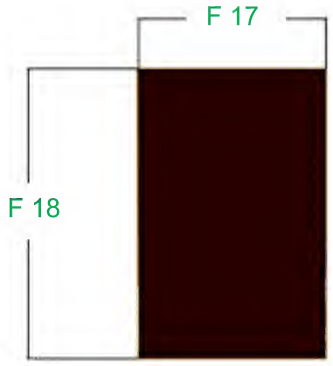


Figure 3.5: Dimension of the back plate of the combustion chamber

4d. Weld the three separate pieces together as shown in Figure 4.6 to create the metal combustion chamber.

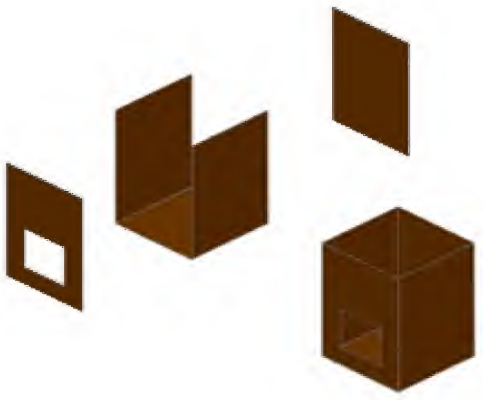


Figure 3.6: mild steel sheet sections welded together to form the metal combustion chamber

IV. PREPARE THE COMBUSTION CHAMBER LINER.

3 options exist for the combustion chamber liner. See appendix A for options. **This manual offers step-by-step plans for producing Option A**

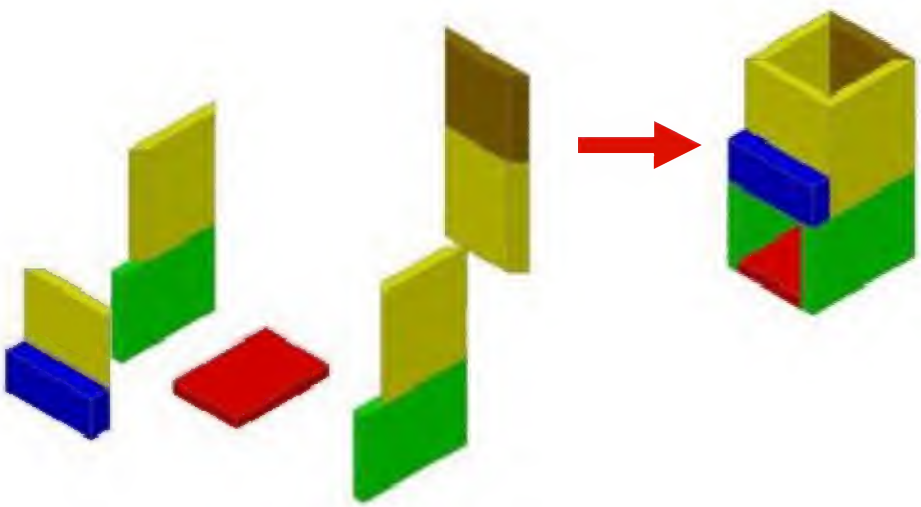
The IRS Excel Guide consists of 2 worksheets: **'mould sizing for clay liners'** and **'metal components'**. On the worksheet named 'mould sizing for clay liners' input the clay shrinkage (all other cells are created automatically from the 'metal component 'work sheet). The Excel Guide will calculate the size of the metal moulds that should be constructed to produce the proper ***post fired*** dimensions of the ceramic tiles. The combustion chamber is made up of nine separate sections.

Location Name =		
Clay Shrinkage rate =	0.00%	
Fuel entrance (X)	F4	cm
Liner thickness =	3.0	cm
Insulation thickness =	5.0	cm

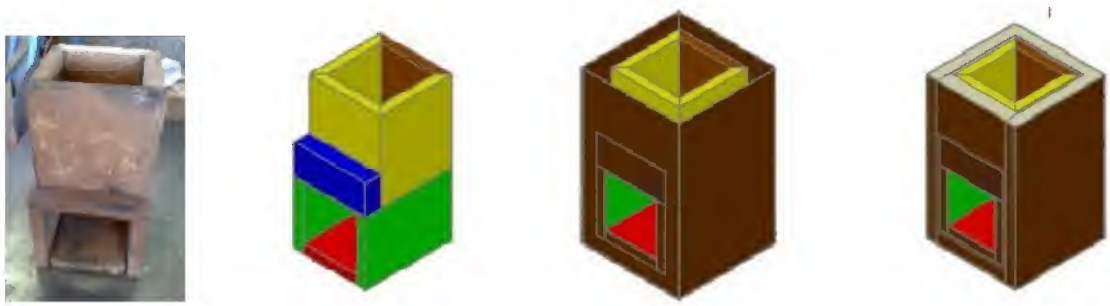
If you are producing the ceramic liner without a mould (e.g. you are cutting pre-fired ceramic or pumice blocks) then input **'0'** in the clay shrinkage column. The Excel Guide will then provide the **exact** dimensions that are needed to produce each of the ceramic tiles.

These liners have beveled edges that when joined will form a miter joint. This is designed to prevent an **inward** collapse of the ceramic sections. The insulation that will be placed between the liners and the sheet metal cladding will prevent the liner from collapsing **outwards**. **Note**: some (but not all) pieces have beveled edges (see excel guide)

Figure 4.2 Assembly of the clay tiles that form the combustion chamber. See Appendix A and excel sheet for exact sizing information.

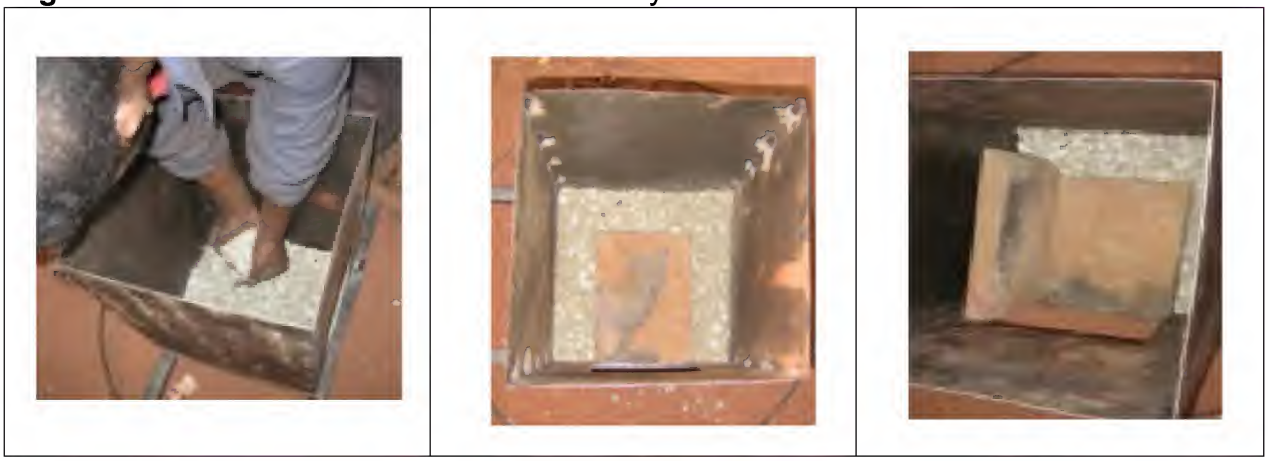


The combustion chamber is assembled inside the metal combustion chamber box and surrounded with insulation.



Place appropriate insulation on the floor of the metal chamber. Fit the pieces together as shown in the photos below. Make sure that the ceramic tiles are centered inside the chamber before filling with insulation.

Figure 4.3: Combustion Chamber Assembly













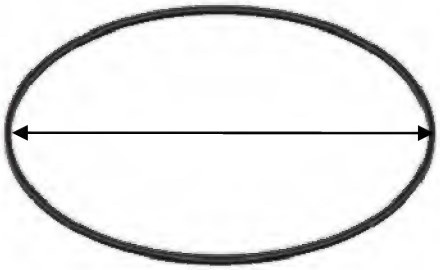

The assembled liner shown inside and outside of the metal combustion chamber box

2 PRODUCE THE STOVE BASE RING

Take a length of 12 mm round bar and cut a length using Formula **21**.

F 21

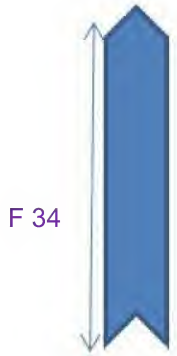
Roll and hammer this into a perfect circle with a diameter equal to Formula **20**.



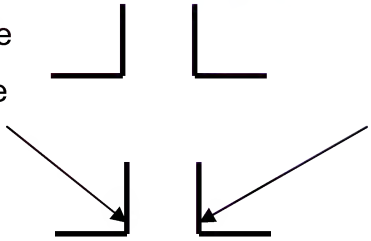
F 20

3 PREPARE THE **LOWER** ANGLE IRON SUPPORTS

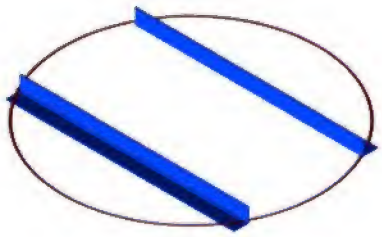
Take a piece of 30 mm wide by 3 mm thick angle iron and cut two lengths equal to Formula **22**. These are angle iron 'A' and 'B', the long combustion chamber supports.



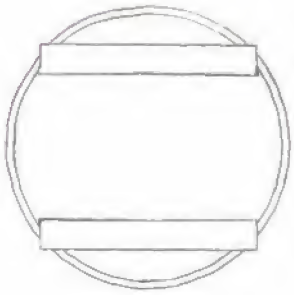
Lay the two lengths of angle iron on level ground so that they make a ' ⌋ ' and a normal ' L' as shown in the drawing right. Then, place the base ring on top of the angle iron so that it fits into the 'crotch' of the angle iron. Weld the supports to the ring.

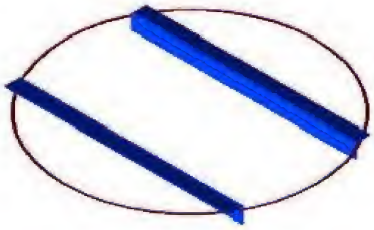


Angle iron pieces must be parallel



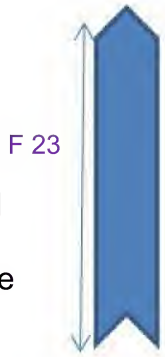
After welding, **flip** the base ring over so that it looks similar to the two drawings to the right.



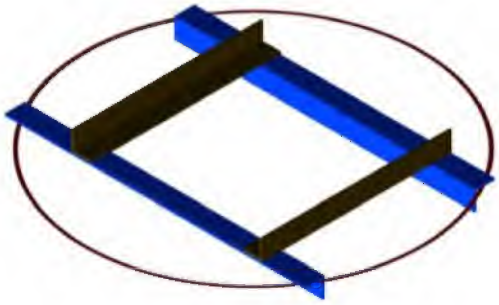


7 PREPARE THE **UPPER** ANGLE IRON SUPPORTS

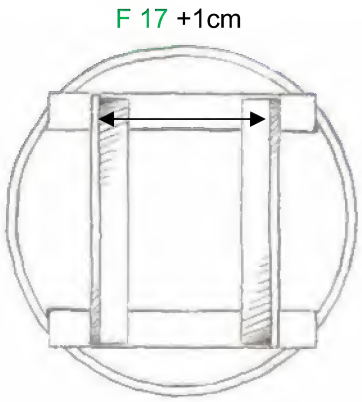
Cut two additional pieces of angle iron in length using Formula **23**. These are angle iron **'C' and 'D',** the short combustion chamber supports.



Place these pieces face up (as shown in drawings below)
Place angle iron sections **'C' and 'D'** on top of angle iron 'A' and 'B'. The distance between **'C' and 'D'** should be Formula **17** +1cm These angle iron must also be placed parallel/equidistant from each other. Use a tack weld to hold the angle iron temporarily in place. Once you are certain that the combustion chamber will fit easily between angle iron **'C' and 'D',** you can use a full seam weld.



3/4 view



Top view

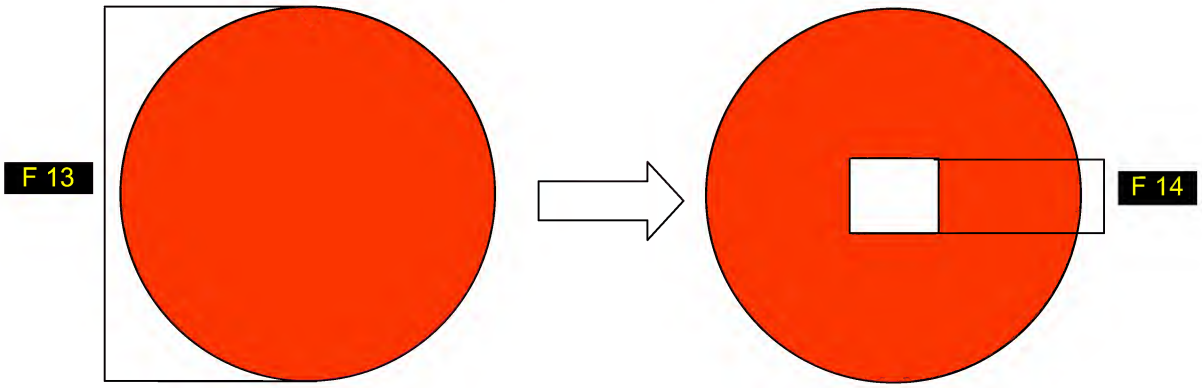
Front view

Confirm that the combustion chamber fits properly inside the angle iron sections but do **not** weld.

8 MAKING THE TOP PLATE

The top plate should be manufactured with 2mm sheet metal. At the center of the top plate there is an opening to the combustion chamber.

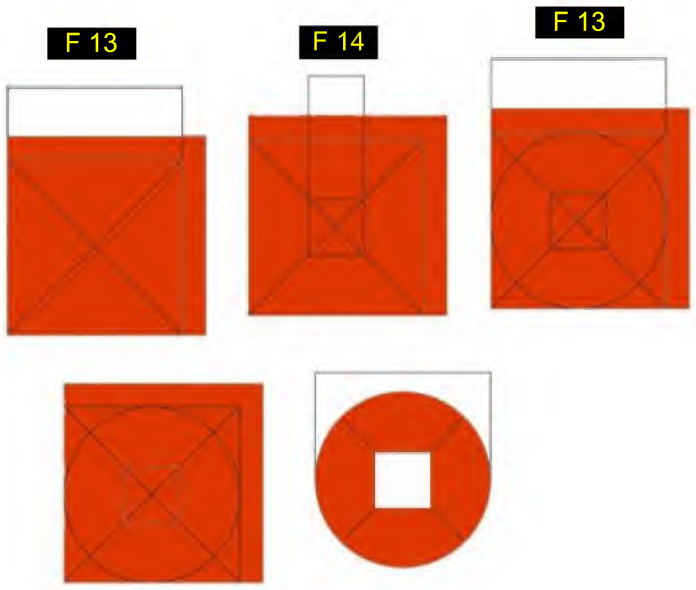
Figure 8.1 Dimensions of the top plate



As it is difficult to center an object within a circle it is preferable that the Top Plate opening should be scribed (but not cut!) **before** cutting the circle. Prepare the top plate in this order:

- Scribe the outer square
- Scribe the inner square
- Scribe the circle
- Cut the inner square
- Cut the outer circle

In other words, mark both the Top Plate **and** the Top Plate Opening before cutting. Do **not** weld the top plate to the combustion chamber

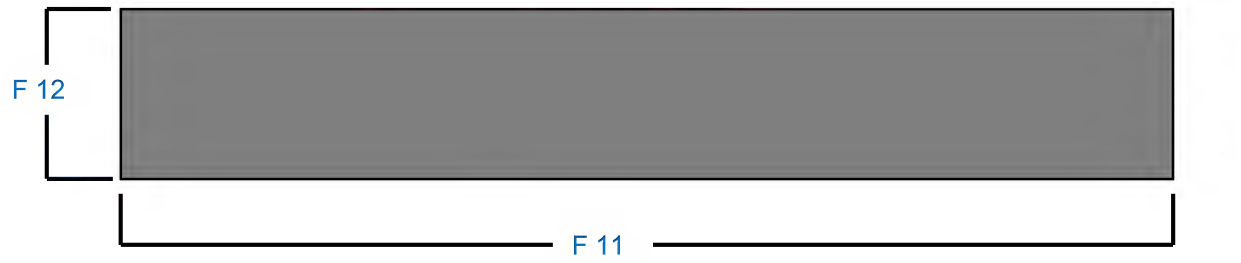


9 PREPARING THE STOVE SKIRTS

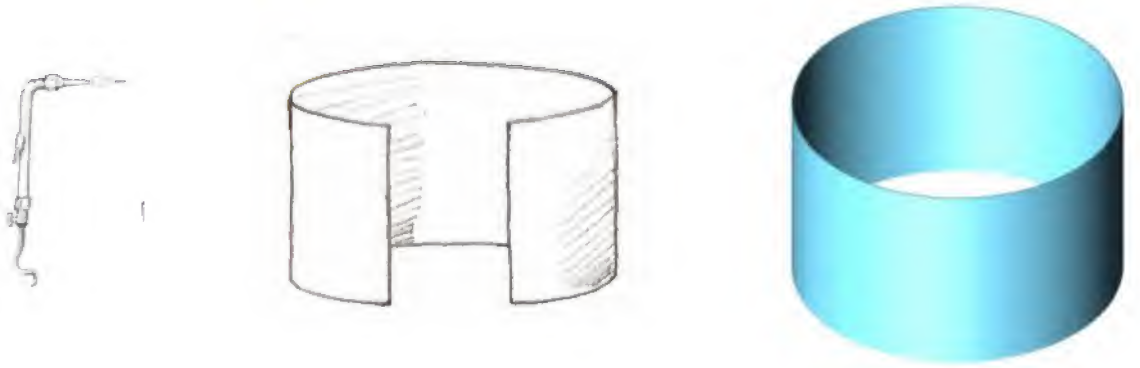
9.1 Produce skirt

Figure 9.1: Dimensions of the outer skirt

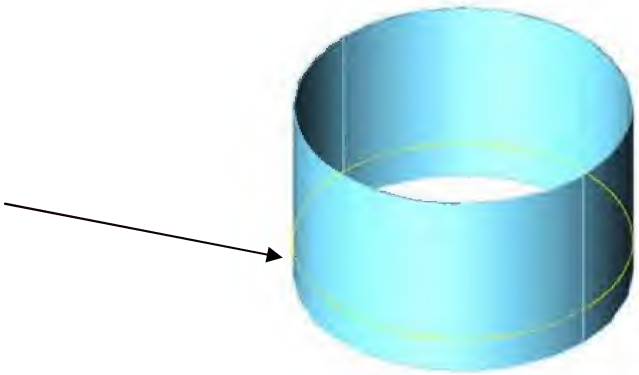
Use the following formula to produce the outer skirt:



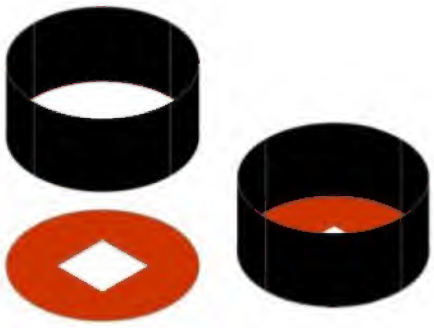
After cutting out the opening, roll the section and tack weld the edges to make a perfect cylinder. Use Formula **13** to check the diameter of the outer skirt.



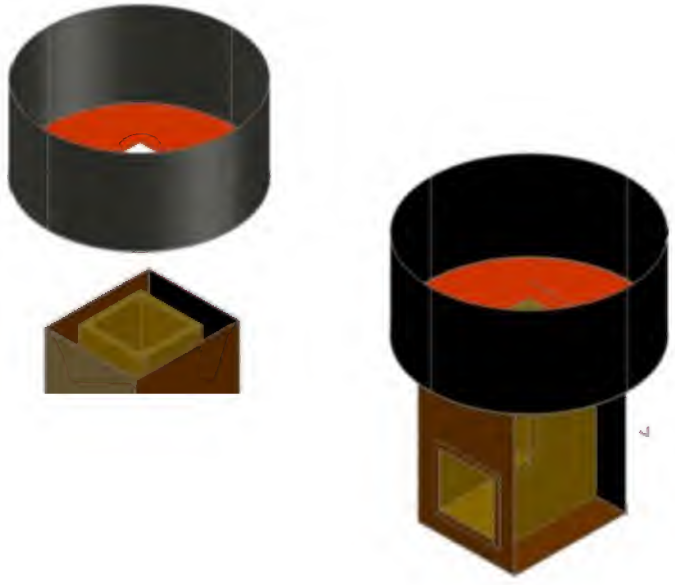
Using a piece of chalk, scribe a circle on the **inside** of the skirt, using the value from Formula **10**, from the bottom edge. After the stove is assembled, this mark will assist in the creation of the insulative slope.



Weld the stove top plate/skirt base to the skirt cylinder. **Be sure the plate is centered on the skirt before welding**. Use 4 tack welds at North, South, East, and West to initially join the base plate to the skirt. Once the skirt is centered more tack welds can be made. Never use a full weld on this seam as it will warp the base plate!

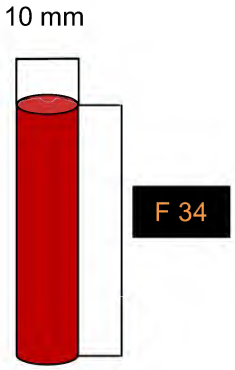


Weld the **top plate** to the **combustion chamber** body. Center the skirt on the stove body. Make sure it is flush with the base ring and angle iron supports. Use multiple tack welds. Do not use a full seam weld.

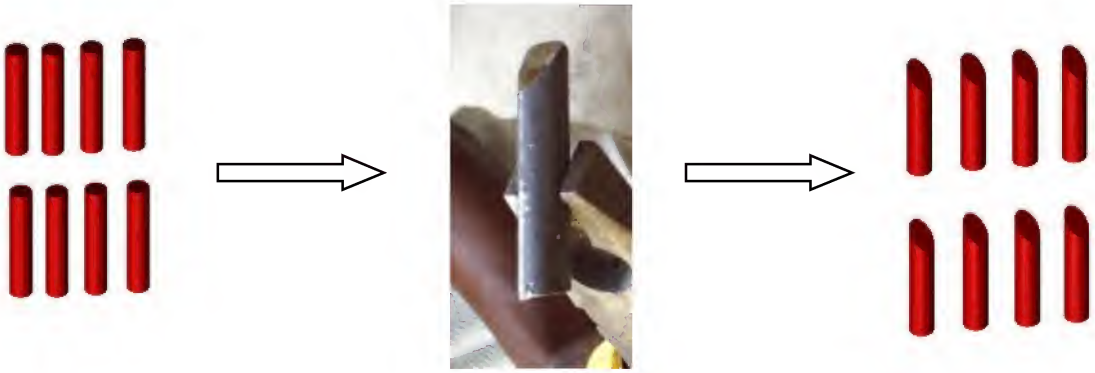


10 POT STABILIZERS

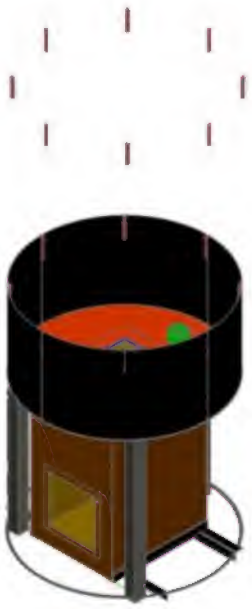
Figure 10.1 Dimensions of the round bar used to produce the pot stabilizer are given by Formula 34.



File a 45 degree edge on the top of each of the round bar/ pot stabilizers (this will allow the pot to enter and exit more easily into the stove body. Produce eight pot stabilizers.



Place the stabilizers so they are equidistant from each other and the **top** of the stabilizer is flush with the **top** of the stove skirt. Weld the first four pot stabilizers at 12, 6, 3, and 9 o'clock. Weld the next four at 1:30, 7:30, 4:30, and 10:30.

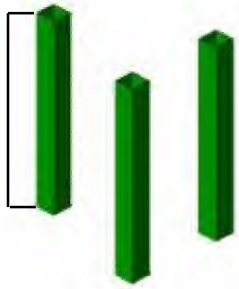


11 MAKE THE STOVE LEGS

The stove has three legs that extend from the bottom of the top plate to the ground. The legs should be made from 40 mm by 40 mm (1.5-3 mm thick) square tube. Use Formula **24** to calculate the length of the legs.

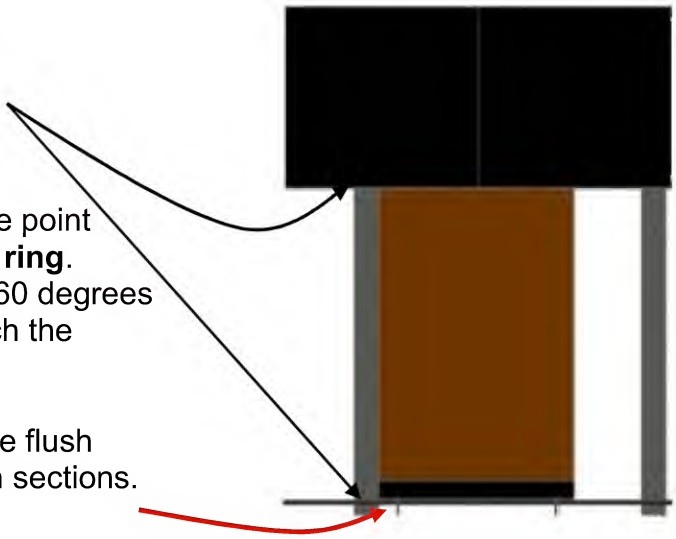
Take a length of square tube and cut 3 pieces.

F 24



The legs should be welded to:

- the **bottom** of the top plate, and
- to the **inside** of the base ring



Ideally the legs should be welded at the point where the **angle iron meets the base ring**. Place the three legs at 120, 240 and 360 degrees respectively. Be sure that the legs touch the ground to ensure a stable platform.

Ensure that the **bottoms** of the legs are flush with the **bottom** of the lower angle iron sections.

12 POT SUPPORTS

Three pot supports are needed. The supports should be made from 40mm by 40mm (1.5-3 mm thick) square tube. These pot supports shall be welded on the top plate with equal distance between them (i.e. at 0, 120 and 240 degrees). Calculate the height of the pot support using Formula **25.**

F 25

For additional reinforcement, a 2 mm thick pot support cap should be placed on top of the square tube to protect the bottom of the cooking pot. Use Formula **26** to calculate the diameter the pot support cap.

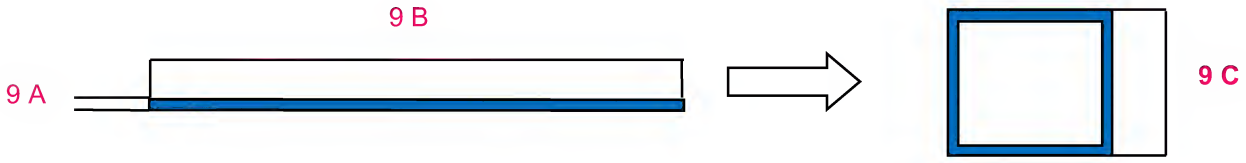
13 INSULATING THE TOP PLATE

The top plate is insulated with a mixture of cement and insulative material such as pumice or vermiculite. The insulation on the top plate will provide the ideal profile for the optimal flow of hot flue gases under the cooking pot. It also protects the top plate from direct contact with the open flame. The insulation on the top plate slopes upward from the Inner Insulation lip out towards the **inner** edge of the **inner** skirt.

13a. Construct the Inner Insulation Lip

The **Inner Insulation Lip** will establish the thickness of insulation at the inner perimeter

Using 1.5 mm metal sheet, make a frame with a height equal to Formula **9A** and a length equal to Formula **9B**. Then fold the metal piece into a square with sides indicated by Formula **9C.**



Weld this frame around the combustion chamber opening in the top plate. The height of the metal sheet will dictate the **thickness** of the insulation at the inner perimeter.

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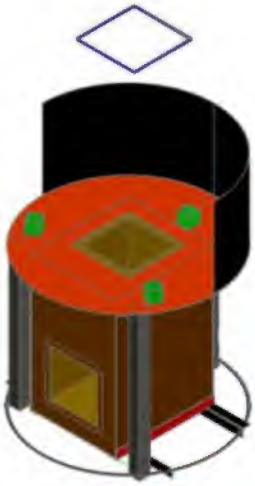
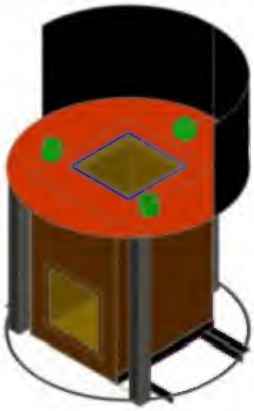




Weld the Inner Insulation Lip to the top plate

13b. In step 8.1 a mark was scribed on the inside of the inner skirt equal to Formula **10.** Using a piece of chalk, highlight this mark a second time.

13c. Prepare the insulative mixture. Mix:

- 5 parts ground pumice (or other suitable insulative material)
- 1 part cement

*Other recipes are also possible. The idea is to create a low density (~0.5g/cc) durable mixture that will not degrade during normal cooking conditions. For example, in Ethiopia we are using a five-part pumice to 1 part cement mixture for insulating the top plate.

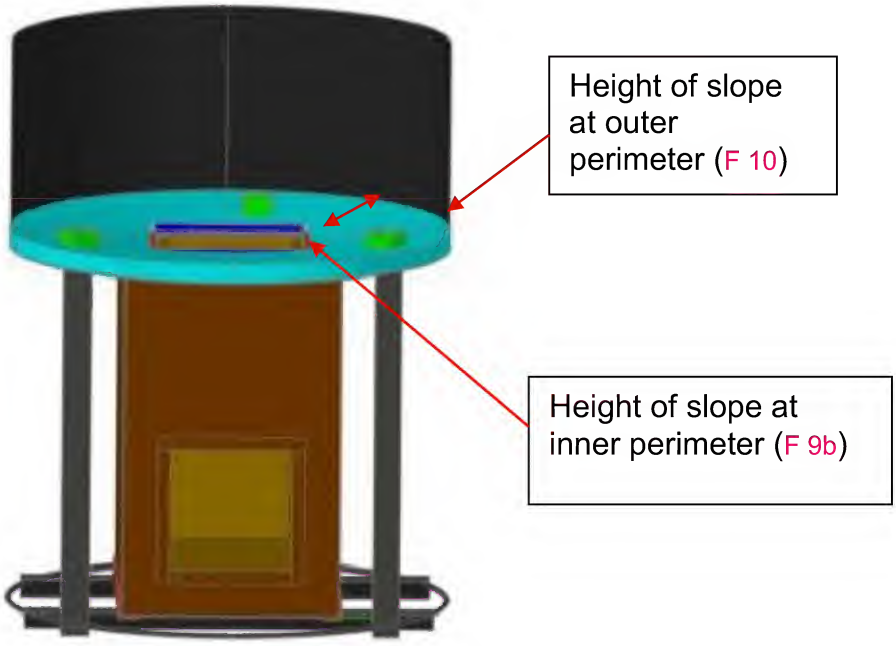
Fill this mixture on the top plate to produce a smooth slope between:

1. the **inner insulation lip** that was described in section 14a, and
2. the **chalk line on the inside of the skirt** that was marked in 14c

As the mixture covers the top plate, it will naturally create a slope upwards starting from the combustion chamber out towards the outer edge of the stove skirt.

Note: It is recommended to slightly under fill the slope to avoid inhibiting the airflow.

Figure 13.1 Diagram showing the top plate insulation



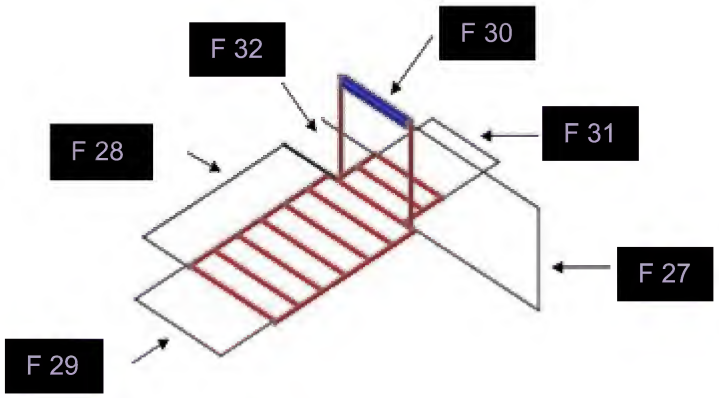
14 WOOD SUPPORT AND WOOD SHELF

The **Wood Support** should be manufactured using a 10 mm diameter round bar.

The **Wood Shelf** should be made with 3 - 5mm thick sheet metal.

The wood support is connected to the stove body via a **15 mm square hollow pipe** which allows the round bar skeleton to enter freely and swivel. **Do not weld the wood support to the square hollow pipe.**

The following formulae can be used to calculate the dimensions of the wood support and the wood shelf:

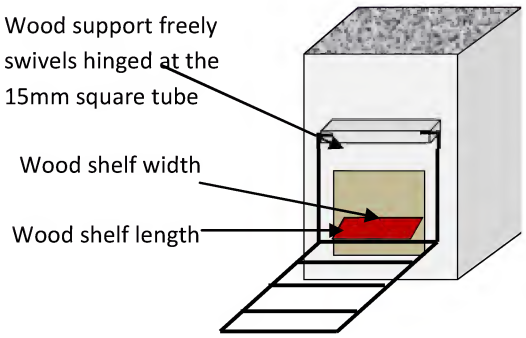


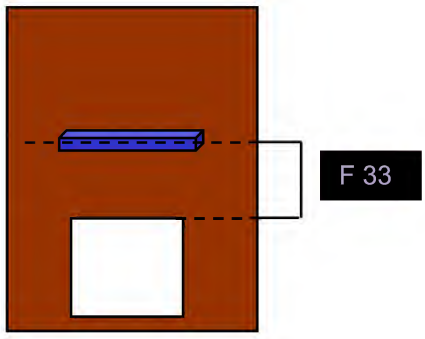
Use Formula 46 to determine the height of the square tube placement **above** the fuel inlet

m square
w pipe

al arm length

al arm length





15 FITTING THE POT INTO THE STOVE

The picture on the left shows the stove without a pot. The picture on the right shows the stove with the pot in place. Notice that there is a small gap between the stove skirt and the pot flange. This gap must be no less than 15 mm. If the gap is too small it will restrict airflow through the stove and reduce performance. To ensure that this gap is present, it is critical to accurately measure the height of the pot.

If the pot has handles, make sure that the top of the skirt is **15 mm** lower than the bottom of the handles. It is important that the pot handles are not supporting the weight

of the pot. The pot should be supported by the pot supports. If the pot is resting on the skirt then the skirt is too high and must be reduced.

The pot should slide easily yet snugly into the stove skirt. If the pot cannot enter into the stove it means that there has been an error in measuring the pot. It is critical to measure the circumference of the pot to the exact millimeter with a soft tape.

To reconfirm that the pot will sit into the stove skirt it is possible to place the pot inside the skirt after step 5 is completed. This should be between 10 and 15 mm between the stove skirt and on all sides of the pot.

16 INSTITUTIONAL ROCKET STOVE USER MANUAL DOS & DON'TS

DO fill the pot with food and water so that it is no more than 2/3rds from the top of the pot. **Use a pot lid:** it can reduce fuel consumption by 70% and decreases cooking times. Less work for cooks!

Do **NOT** overfill the pot. This will cause the pot to boil over. The water will damage the insulative top plate and produce smoke.

DO use the shelf. This will save time and wood as well as producing less smoke

Do **NOT** remove the shelf and overfill the combustion chamber with wood.

DO use the proper size pot. The pot should fit snugly inside the stove and create a 1 cm gap between the pot and the skirt. **Regardless of whether you are cooking 10 litres or 100, the same pot should always be used!**

Do **NOT** use a smaller pot as it is less efficient and it can damage the stove. Due to the stove's special design, a larger pots will cook more efficiently than a smaller, ill fitting one.

DO Remove all of the ashes and charcoal **just before cooking each meal** For the stove to work properly, air must be able to enter under the shelf at all times .

Do **NOT** force large pieces of wood into the stove -it will break the special bricks!

DO store the stove and the wood in a dry place.
DO use the stove inside or outside the kitchen but…
DO handle the stove with care

Do **NOT** use water to clean the stove
Do **NOT** ever expose the stove to rain or moisture.
Do **NOT** drop the stove or treat it roughly

DO scrap the soot from the inside of the inner skirt and the top plate every few months (or as needed)

For information about stove maintenance, replacement parts or to place an order for additional stoves please contact **:**

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For additional information please contact Mercy Corp?